Plasticizing Silk Protein for On-skin Stretchable Electrodes

Geng Chen, Yajing Cui, Zhuyun Li, Xiaodong Chen*

* Innovative Centre for Flexible Devices (iFLEX), School of Materials Science and Engineering, Nanyang Technological University, 50 Nanyang Avenue, Singapore 639798 (chenxd@ntu.edu.sg)

Abstract

Soft and stretchable electronic devices are important in wearable and implantable applications because of the high skin conformability. Due to the natural biocompatibility and biodegradability, silk protein is one of the ideal platforms for wearable electronic devices. However, the realization of skin-conformable electronic devices based on silk has been limited by the mechanical mismatch with skin, and the difficulty to integrate stretchable electronics. Here we demonstrate silk protein as the substrates for soft and stretchable on-skin electronics. The original high Young's modulus (10 GPa) and low stretchability (<10%) are tuned into 0.1~2 MPa, and >400%, respectively. This plasticization is realized by the addition of $CaCl_2$ and ambient hydration, whose mechanism is further investigated by molecular dynamics simulations. Moreover, highly stretchable (>100%) electrodes are obtained by the thin-film metallization and the formation of wrinkled structures after ambient hydration. Finally, our plasticized silk electrodes, with the high electrical performance and skin conformability, achieved on-skin electrophysiological recording comparable to that by commercial gel electrodes. Here proposed skin-conformable electronics based on biomaterials will pave the way towards the harmonized integration of electronics into human.

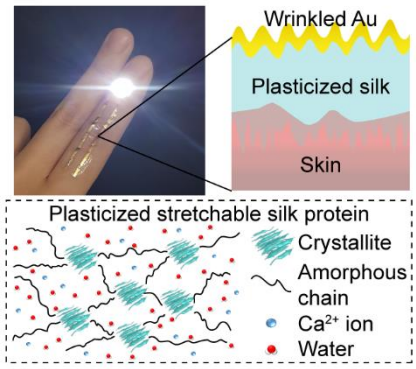

Figure 1: Scheme of plasticized silk electrodes on skin.

References

[1]. Chen, G.; Matsuhisa, N.; Liu, Z.; Qi, D.; Cai, P.; Jiang, Y.; Wan, C.; Cui, Y.; Leow, W. R.; Liu, Z.; Gong, S.; Zhang, K.-Q.; Cheng, Y.;* Chen, X.* "Plasticizing Silk Protein for On-skin Stretchable Electrodes. Advanced. Materials. Vol. 30, 1800129, 2018.